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ABSTRACT

This paper describes the installation of a data network in the community of Glenview, Illinois, which uses broadband cable equipment to connect schools, libraries, and governmental agencies to each other and to the Internet via a high speed Ethernet network. The history of the project is outlined followed by a discussion of the implementation of the network. It is noted that a strong effort was made to provide the same services to all users of the network. The services available include electronic mail, telnet, file transfer protocol (FTP), Gopher, World Wide Web (WWW), the online public access catalogs (OPACs) of local libraries, and, to a limited audience, USENET news. The technical aspects, site setups, equipment used, and the operation and maintenance of the network are examined. Finally, several lessons learned from the implementation of the project are presented: (1) the cable plant was old, unused, and untested, and required more time to make it operational; (2) initial lack of expertise to make the broadband cable equipment operational in an outdoor, public television cable environment caused conflict between two of the installers of the system; (3) the equipment is both temperature and signal level sensitive; (4) users anticipated problems where there were none, hesitated to try new things, or failed to realize what was available; and (5) political realities kept some sites from connecting. A system to deliver Internet connectivity to the home via the public cable is currently being explored. (JLB)

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# The Glenview Model: Community Networking Via Broadband Cable

by John P. Mundt

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# The Glenview Model

## *Community Networking via Broadband Cable*

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## OVERVIEW

This paper details the installation of the data network in Glenview. It uses broadband cable equipment to connect schools, libraries, governmental agencies, and other organizations to each other and to the Internet via a high speed Ethernet network. At present, it appears to be the least expensive model now being presented for the interconnection of local sites to each other and to the Internet.

Glenview, IL, is a racially and economically diverse suburb on the north side of Chicago, housing several corporate headquarters as well as a naval air station. Comprised mainly of single-family homes, the 30,000 residents are served by 3 school districts, a public library, and several village governmental agencies.

The establishment of a network throughout a community is very expensive; so is the maintenance of that network. The cost of a direct Internet connection is also quite expensive. The Glenview model lessens the effective cost by using two tried and true methods. One is cost sharing. The other is to get someone else to pay for it.

Important to this discussion, then, is TCI, Inc., the cable company holding a franchise agreement with the town of Glenview. They paid for the network 10 years ago. They pay for its maintenance now. All schools and government agencies had to do was to connect to an existing network with relatively simple and inexpensive equipment. Using the existing CATV network allowed for the quick implementation of that network. Maintenance becomes a cost of doing business in the community.

At present, seven schools, a district office, a public library, an educational service center, and the bulletin board of a state-wide teacher professional computer organization constitute the community network. The village government comes on-line in the spring, and four other school districts are slated to join next year. A local hospital, which may also join the consortia, was originally not included because no one remembered that they had been wired for the INET ten years ago. Reading the franchise agreement recently showed that there were several other potential members of the network who as yet have not been informed of their ability to connect.

## HISTORY

The Glenview model owes much of its success to being in the right place at the right time and several events had to coalesce to make it feasible. First, a number of civic committees and organizations were aware of the potential of network connections and were eager to find a method of interconnection. Meetings over several years led to a felt need to internetwork, and a consensus that this would be done when it was technically and economically practical.

The cable franchise agreements, typical of approximately 40% of those in the Midwest, had established a separate bidirectional cable system in the village which had lain fallow for ten years. It proved to be possible to restore it to working order quickly and easily. Zenith, who made the CATV network

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equipment ultimately used, was based in Glenview and was looking to expand their market. netILLINOIS, the Internet service provider, was newly created and looking for K-12 schools to connect up.

Schools were discovering the resources available on the Internet. The head of the public library, a very technologically savvy individual, also wanted to see his library make use of Internet resources. Client programs, such as TurboGopher, Eudora, Mosaic, and NCSA telnet were being developed and were in the public domain. A school superintendent, hooked on e-mail, wanted a more reliable transport mechanism than the phone link to a public bulletin board system in Chicago run by hobbyists then in use.

The CEO of TCI announced a multi-billion dollar commitment to education, for both video and data. The Glenview schools already had extensive building networks and a series of UNIX host machines in each building, connected via modems, for e-mail and file exchange. These provided the raw material for connection.

The final go-ahead was given after the possibility of a cable connection was rediscovered at a technical meeting. This made the cost fall within reasonable limits. Commitments by three organizations to share the cost were given orally at that meeting, and the process was started before anyone had a chance to back out.

## IMPLEMENTATION

Implementation began in the late fall of 1992 following discussions with Zenith, TCI, netILLINOIS and Compatible Systems. By January, the first three links were in place, connecting the administration building with two schools chosen for furthest distance and greatest traffic.

It was soon found that signal levels were wrong at one site, and the cable was defective to the second. Several weeks of repairs, adjustments, and finger-pointing between Zenith and TCI ensued. After a joint meeting, the three sites became operational on a regular and stable basis by April. During the rest of the summer, the other sites were placed on line.

During this time, considerable time was spent in setting up the domain name servers on three machines, pointing other machines at these name servers, establishing the sendmail configuration files and alias files necessary for mail routing. On the Apple side, the AppleTalk networks were interfaced with each other through TCP/IP tunnels between sites, renamed to more a more logical structure, and the software necessary to operate as peers on the Internet were brought together, tested and made generally available to users.

Gopher clients were placed on the UNIX hosts for terminal/host emulation, library public access catalog programs modified to allow access to other catalogs and gopher, and file sharing between the various platforms established using the NFS protocol. Routing of mail and files was changed from the older dial-up phone mechanism to the community network.

On August 16, 1993, everything was up, all sites connected, talking one to another, and the extended trial period was over. Since that time, the entire network has never been entirely down. A large portion of the network was down 2 days thanks to heavy snow and an errant snowplow. Temporary outages to different sites have added another day or so.

## SERVICES AVAILABLE

A major design criterion of this project was platform independence. Regardless of the location or the hardware, a strong effort was made to provide the same services to all users on the machine of their choice. In general, what is available via the terminal/host metaphor is also available in the client/server model. UNIX host machines can, in general, provide the computing horsepower and programming for both in a manner as transparent to the user as possible. They also allow a mechanism to allow dial-in connections that still are subject to an authorization procedure.

Before speaking of new services, the existence of the network had a great effect on old services. E-mail was now virtually instantaneous and a whole lot more reliable. File transfer also became easier. Backups could be done more often. Phone lines which had to be left clear for inter-machine traffic could now be freed up for dial-in.

What new services became available? First and perhaps the most useful service is electronic mail, and while not new, this network expanded it. Users exchange electronic mail throughout the community, the nation, and the world with equal ease, based on the naming conventions established for the Internet community. Listservs, special interest electronic mail sent to enrolled members, has become a large part of the e-mail flow into the community.

Next in importance are the standard programs of the TCP/IP world—telnet and ftp. These are made available for terminal/hosts or client/server machines. The two most popular Internet search engines, gopher and WorldWideWeb are also offered both ways. These programs bring Internet resources, from files, to programs, to databases, to library catalogs to on-line e-text, to graphics, audio, motion pictures, to interactive conferencing and a lot that has yet to be mentioned.

Local resources such as the on-line public catalogs of all local libraries are available to all. File sharing across the community is available in a transparent manner so that in large part, users are not even aware that the files they are accessing are not local to their own building or machine. In one particular case, an Apple technical CD-ROM in one location is now available in all locations allowing for greatly simplified updating and maintenance.

Net news, available now to a very limited audience, is about to be offered in a pilot, moderated basis to students. A full feed for everyone is anticipated by the fall of 1994. A single news server machine can be shared across the community, minimizing costs.

In general, dialing into one site allows access to another. Approximately a dozen phone lines are available for community members, staff and students to connect to the various host computers. At the present time, a person must have an authorized login on a machine to gain access. Users at one site can generally access their home computing systems.

System maintenance is simplified by the ability to control things from a central point and to make services installed on one machine usable by users at other sites. Technical expertise can be shared among organizations avoiding duplication.

As a side benefit, the reactivation of the INET allowed sites to initiate video feeds to the head end when they had been limited to only a few sites in the past. It will be possible to use the satellite dish of a single location to feed video to the entire community.

## TECHNICAL ASPECTS

TCI of Illinois, as a part of its franchise agreement, had originally installed two separate cable systems. The first, the standard public cable, ran to all houses, businesses, and organizations in the community. A separate system, called the institutional net, or INET for short, ran only to schools, government buildings, libraries and hospitals.

This INET had been used by various organizations to transmit a video signal to the cable head end, where the signal was rebroadcast to the public cable system. However, the INET was bidirectional, allowing signals to travel in both directions and allowing the creation of a data network configured in a star topography.

Zenith Corporation markets a series of Ethernet to RF broadband converters. Using two channels on the INET, data from each location's Ethernet are converted and broadcast up the first channel to the head end, where they are rebroadcast down the second. All converters listen to this second channel, converting and placing data onto the local Ethernet. Each location needs but a single network connection point to the broadband where routers limit traffic to or from the local site.

With everything in place, a wide-area network running at 4 megabit per second was created. It was slower than a standard 10 megabit Ethernet, but three times the speed of the present Internet connection. Each site has its own Class C Internet address, simplifying routing. The single dedicated link to the Internet was established at one site and connected to the network. This had the effect of giving each site its "own" Internet connection. Originally running at 56 Kbits, it was upgraded to 1.5 megabit in March of 1994.

The school system handles domain name service for all parties involved at the present time. Two domains have been created and registered, namely NCOOK.K12.IL.US, envisioned to encompass suburban schools immediately north of Chicago, and GLENVIEW.LIB.IL.US, which holds the public library.

## SITE SETUPS

Once in a building, the configuration can and does vary. Each of the 7 schools in District 34 are configured with an Ethernet backbone connecting UNIX hosts in library and office. These hosts provide school management software, the circulation and on-line public catalog for each school's library, terminal emulation, e-mail connectivity, and dial-in access. One or more AppleTalk networks in each building are bridged to the backbone by multi-function routers and or GatorBoxes, which also provide IP addresses on demand.

The public library presently has a single point of connection to a UNIX box acting as e-mail server, gopher server, and firewall between the Internet and the CLSI circulation computers. A firewall makes it far more difficult for hackers to corrupt the library systems.

The North Cook Educational Service Center has extensive in-house networking based almost entirely on Macintosh equipment. The router bridges to this preexisting EtherTalk network creating the easiest connection of the current sites.

Illinois Computing Educators "School Board," a BBS for Illinois educators is located in the schools' administrative center and makes use of the Internet connection to provide access to network services. Running on a Macintosh IIfx donated by Apple Computers, two phone lines are presently available to educators in the area. Users with Internet access can telnet into the School Board. Additional phone lines will be added shortly as part of a projected shared phone bank.

The village government, as yet awaiting connection, will be running a Lantastic network which will use bridges to tunnel through the community network to individual sites. Yet to be decided is the gateway system for handling electronic mail.

## EQUIPMENT

The equipment needed to build a community network over broadband is simple. Each site has two pieces, a router and a broadband converter. In addition, a single repeater is required at the cable company head end.

The broadband equipment we chose is manufactured by Zenith Corporation, headquartered in Glenview. We chose the ChannelMiser, the least expensive model, which converts Ethernet to broadband and back again. Signals are transmitted on one frequency and received on another. The ChannelMiser listens for the return of its own signal and retransmits in case of error. It will broadcast TCP/IP, LocalTalk, or IPX packets, though at present only TCP/IP packets are used. LocalTalk packets are encapsulated inside of TCP/IP packets for retransmission. Higher end models offer routing, bridging and other more sophisticated services not deemed necessary for the Glenview network.

The repeater at the head end listens on one channel and repeats everything received onto the second channel, spread approximately 150 MHz apart from the first. The repeater does not attempt to regulate signal level, nor does it clean up the signal in any way.

In order to minimize network traffic, and provide bridging between AppleTalk, Novell and TCP/IP, routers from Compatible Systems of Boulder, Colorado were placed at each location. The RISCRouter 3000E chosen routes between two Ethernet TCP/IP and two AppleTalk networks, bridging between the two different protocols. The Internet service provider, netILLINOIS, established and maintained the Internet connection and included its own router and associated equipment. The costs of the yearly membership and the leased dedicated line are shared among the participants.

## OPERATION AND MAINTENANCE

Once installed, equipment has proved to be extremely reliable. The network was designed along a simple model that was cloned in as many locations as possible. This makes monitoring the network a simple task. The Zenith equipment needs to be set only once. Routers, once programmed, share and update routing information automatically, and need to be told of new installations only when special privileged connections are needed. TCI is responsible for the maintenance of the cable plant, Ameritech the leased phone line, and netILLINOIS the Internet connection hardware.

The single most common point of failure are the broadband amplifiers strung around the community. These are prone to failure from excessive temperatures, and one in particular to snow plows and cars failing to make a bend in the road. As the cable plant is moved away from copper cable to fiber, reliability will increase. Presently, the system has been operational in excess of 98%.

## LESSONS LEARNED

The Glenview community network is a success, but its implementation has not gone as easily as it might have. The following unforeseen difficulties had to be overcome and would probably be typical of many other installations:

1) The cable plant was old, unused and untested. Many amplifiers were inoperative and cables damaged. It took a longer period of time to make them operational and to adjust signal levels than was anticipated.
2) Initially, neither Zenith nor TCI had the expertise to make the broadband equipment operational in an outdoor, public TV cable environment. Not surprisingly, both blamed the other for failure. It required many meetings of operating engineers on both ends to iron out the difficulties.
3) The equipment remains temperature sensitive on the TCI side, and signal level sensitive on the Zenith side. While operational within a broad range, temperature extremes last summer and winter have caused decreased throughput or temporary outages. Response time for repairs or adjustments has been haphazard, with problems not being addressed as quickly as possible.
4) Integrating building networks together proved to be a no-brainer.

Getting staff to use and understand the expanded network, which worked just like a local one, proved to be more difficult. Users anticipated problems where there are none, hesitated to try new things for fear of destroying everything, or lacked the conception of what was available. More training into the conceptual nature of the network should have been provided.

Because it wasn't done, at all sites have progressed to the same level . While some users have charged ahead, others have made little use of network resources. By far, the most successful determiner for a successful building is a core of highly motivated, excited users. A trivia contest, e-mail to children at college or oversees, graphical images, sound bites, and other gee-whiz applications are needed to start people using network services.

5). Political realities have kept some sites from connecting. The inaction of committees, cautious or unaware administrators, unbelievers and luddites have all taken their toll. The issues of territory and control of information have affected the decisions of many organizations.

## THE FUTURE

Expansion of the network is easy once components are in place. A community-wide shared phone bank using terminal servers directly connected to the Internet will allow easier access, SL/IP and PPP access for client/server software, and reduce costs. WorldWideWeb clients, net news clients, and other user friendly software will be added as they become available. Packet video and audio is being used at one school and will be implemented at more locations as experience in these media grow. The public library anticipates creating a bank of public terminals/client computers for library patrons.

One of the original goals of the network was to share data between governmental bodies, with different agencies maintaining shared databases. Now that the network has been in place and has proven itself, plans for this sort of sharing are going forward.

TCI is pursuing a system that would deliver Internet connectivity to the home via the public cable. It should be easy to link the two systems together to provide greater speed to users in the home.